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New species and new records of the lichen genus *Fuscopannaria* from China

Hua-Jie Liu*, Jian-sen Hu & Qing-feng Wu

College of Life Sciences, Hebei University, Baoding, 071002, China

* Correspondence to: *liuhuajie@foxmail.com*

Abstract —Four species belonging to the lichen genus *Fuscopannaria* are reported from China: *Fuscopannaria rugosa* sp. nov., *F. cheiroloba* (new to Asia), *F. coralloidea* (new to Asia), and *F. protensa* (new to China). Descriptions and comments for the four species are presented. The type specimen of *F. rugosa* is deposited in HMAS-L.

Key words —*Ascomycota*, *Peltigerales*, *Pannariaceae*, taxonomy

Introduction

Fuscopannaria P.M. Jørg. is a mainly warm-temperate genus belonging to *Pannariaceae*, *Peltigerales*, *Lecanoromycetidae*, *Ascomycota* (Jørgensen 2008, Kirk et al. 2008). It differs from other genera in the family by having a cyanobacterial photobiont (*Nostoc*), a hemiamyloid hymenium, asci with apical amyloid ring-structure, and the presence of thalline margin and absence of lichen substances (terpenoids and fatty acids are sometimes present). It contains about 50 species worldwide (Jørgensen 2003, 2004, 2007, 2008). Fourteen species have been reported from China (Wu & Qian 1999; Jørgensen 2000a, 2004, 2007; Obermayer 2004). *Kroswia* has recently been suggested to be included in *Fuscopannaria* (Magain & Sérusiaux 2014, 2015), but this classification is not followed in the present study (see Liu et al. 2015).

In this paper, *Fuscopannaria rugosa* is described as a new species, *F. cheiroloba* and *F. coralloidea* are reported as new to Asia, and *F. protensa* is reported as new to China.

Materials & methods

Specimens are housed in Herbarium Mycologicum Academiae Sinicae-Lichenes, Beijing, China (HMAS-L), the Herbarium, Kunming Institute of Botany, Chinese

Academy of Sciences, Kunming, China (KUN), and the Herbarium of Shandong Normal University, Jinan, China (SDNU). Morphological, anatomical, and chemical studies were conducted on all specimens following Liu et al. (2015).

Taxonomy

Fuscopannaria rugosa H.J. Liu & J.S. Hu, **sp. nov.** Pl. 1

MycoBank MB 812172

Differs from *Fuscopannaria leucosticta* in the foliose-squamulose thallus, longitudinally wrinkled upper surface, and highly convex discs.

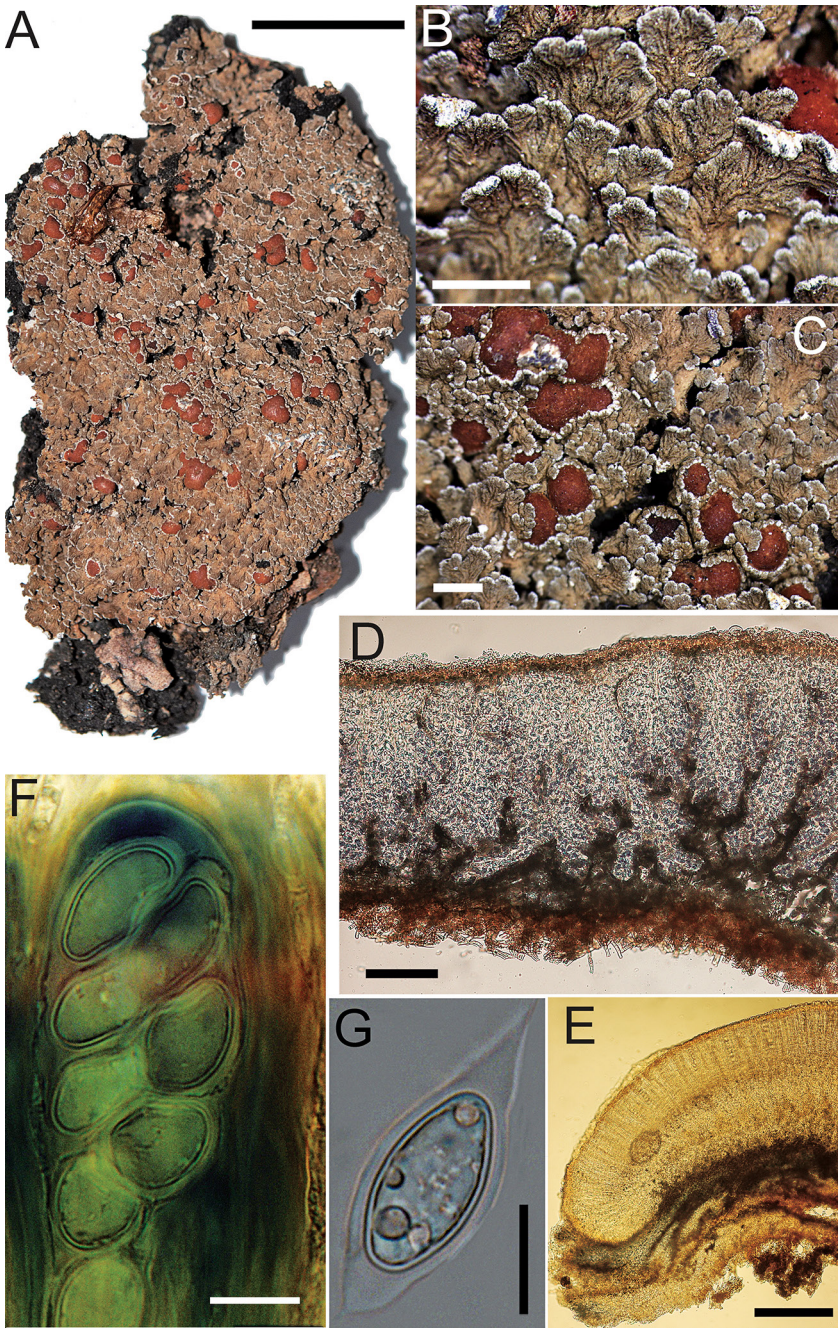
Type: China. Hubei Province, Mt. Shennongjia, 31°30′N 110°16′E, alt. 2540 m, on bark, 30/VII/1984, Jian-Bin Chen 11059 (**Holotype**, HMAS-L 098090).

Etymology: The epithet refers to the wrinkled upper surface.

Thallus foliose-squamulose, forming orbicular rosettes, ≤4–5 cm in diam.; lobes imbricate, fan-shaped, 0.5–1.5 mm wide, branched, flat, free at margin, soon attached to hypothallus towards center, the ends often crenulate and commonly white-felted (ecorticated and exposing the white hyphae); upper surface brown, or sometimes dark olive-green (in particular the "old" lobes), glabrous, shiny, not scabrid, longitudinally wrinkled (wrinkles sometimes indistinct on mature portions), plicate at margin, without isidia, lobules, soredia and pruina; algal layer distinctly dark blue under 10× magnification; lower surface pale near margin, variably becoming dark brown to black towards center, no distinct rhizines and tomenta observed; hypothallus distinct or sometime indistinct, dark brown to black, protruding or not. Apothecia abundant, laminal to submarginal, adnate, circular when young, irregular and 1–2(–2.5) mm in diam. when mature; disc red-brown to paler, shiny, smooth, highly convex when mature; thalline margin glabrous, crenulate and white-felted marginally, distinct, but sometimes covered by disc when mature; proper margin not seen.

Thallus heteromerous, 250–400 μm thick; upper cortex brown, 20–40 μm thick, cells thick-walled; algal layer 200–300 μm, *Nostoc* cells in chains, blue, embedded in a gelatinous layer; medulla thin, 20–30 μm thick, white near lobe margin, blackened towards center and merging into the dark brown to black rhizohyphae; lower cortex absent.

Plate 1. ***Fuscopannaria rugosa*** (holotype, HMAS-L 098090). A. Thallus with apothecia; B. Upper surface, showing fan-shaped lobes with longitudinal wrinkles, crenulate and white-felted margins; C. Apothecia, showing crenulate and marginally white-felted thalline margin; D. Cross-section of thallus; E. Cross-section of apothecium; F. Ascus and ascospores, showing the amyloid ring structure of ascus apex; G. Ascospore, showing distinct, smooth epispore with acuminate ends. Scale bars: A = 1 cm; B, C = 1 mm; D = 100 μm; E = 150 μm; F, G = 10 μm.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Apothecia lecanorine, ≤500 μm thick; thalline exciple 100–150 μm thick at margin, with cortex and algal layer similar to the thallus; proper exciple not seen; epihymenium brown, 10–15 μm thick; hymenium 135–150 μm thick, hemiamyloid (I+ blue, rapidly turning red-brown); subhymenium 160–180 μm thick, without distinct cells; the underneath medulla and algal layer 100–150 μm thick; asci with apical amyloid ring-structure, 8-spored; ascospores monostichous to distichous, simple, ellipsoid, hyaline, true spores 12.5–17.5 × 9–11 μm, 20–30 × 10–12 μm with epispore; epispore acuminate at both ends, smooth, colourless.

Corticolous.

Chemistry: All reactions negative (color test); terpenoids and fatty acids present (TLC).

Additional specimens examined: **CHINA. Hubei Province**, Mt. Shennongjia, 31°30′N 110°16′E, on bark, alt. 2250 m, 30/VII/1984, J.B. Chen 11136 (HMAS-L 098089). **Guangxi Province**, Huaping National Nature Reserve, 25°34′N 109°53′E, on bark, alt. 900–1000 m, 15–17/VIII/1964, J.D. Zhao & L.W. Xu 08710 (HMAS-L 105146), 08857 (HMAS-L 105152), 09038 (HMAS-L 105157).

Remarks: *Fuscopannaria rugosa* is characterized by the foliose-squamulose thallus with longitudinal wrinkles on upper surface, the distinct hypothallus, the thalline and apothecial cortex of thick-walled cells, the thick algal layer (200–300 μm) and simple, hyaline ascospores with a smooth, apically acuminate epispore. The species is corticolous in montane forest from Hubei and Guanxi.

Fuscopannaria rugosa belongs to the *F. leucosticta* group, based on its heteromerous thallus with terpenoids and fatty acids, white-felted lobe margin and apothecial margin, crenulate thalline margin, asci with apical amyloid ring-structure, and smooth epispore. It differs from all other taxa in the group in having distinct, coarse and longitudinal wrinkles on the upper surface. It should be noted that the occasional less than distinct wrinkles and disappearing hypothallus may lead to a confusion with other species in the group. Of these, *F. leucosticta* (Tuck.) P.M. Jørg. can be distinguished by round, broader (>1.5 mm broad) squamules and plane discs; *F. protensa* has a pale brown-ochre, scabrid upper surface; and *F. siamensis* P.M. Jørg. & Wolseley has secondary lobules on the upper surface and smaller spores (18–20 × 9–10 μm; Jørgensen 2000a).

Fuscopannaria cheiroloba (Müll. Arg.) P.M. Jørg., Bryologist 103: 679 (2000). Pl. 2 A–E

Thallus squamulose, usually forming a crust of 3–5 cm in diam.; central squamules dense, granule-like and giving the center of thallus a crustose appearance; marginal squamules spreading, loosely imbricate, free at margin, fan-shaped, ≤3 mm wide, fragile, always incised, not white-felted marginally;

UPPER SURFACE brownish to yellowish-brown, glabrous, smooth, dull to slightly glossy, without isidia, lobules, soredia and pruina; LOWER SURFACE whitish near the margin, darker towards the center, attached to the substrate by hyphae; HYPOTHALLUS commonly indistinct. APOTHECIA abundant, often crowded, laminal to submarginal, sessile, ≤1 mm in diam.; DISC brown to dark brown, smooth, convex; THALLINE MARGIN excluded.

THALLUS heteromerous, thicker in the central squamules, ≤300 μm thick; UPPER CORTEX distinct, 30 μm thick, cells thick-walled; ALGAL LAYER 120–130 μm, *Nostoc* cells in chains, embedded in a gelatinous layer; MEDULLA 30–40 μm thick, with hyphae more compact in upper part, but looser in lower part; LOWER CORTEX absent.

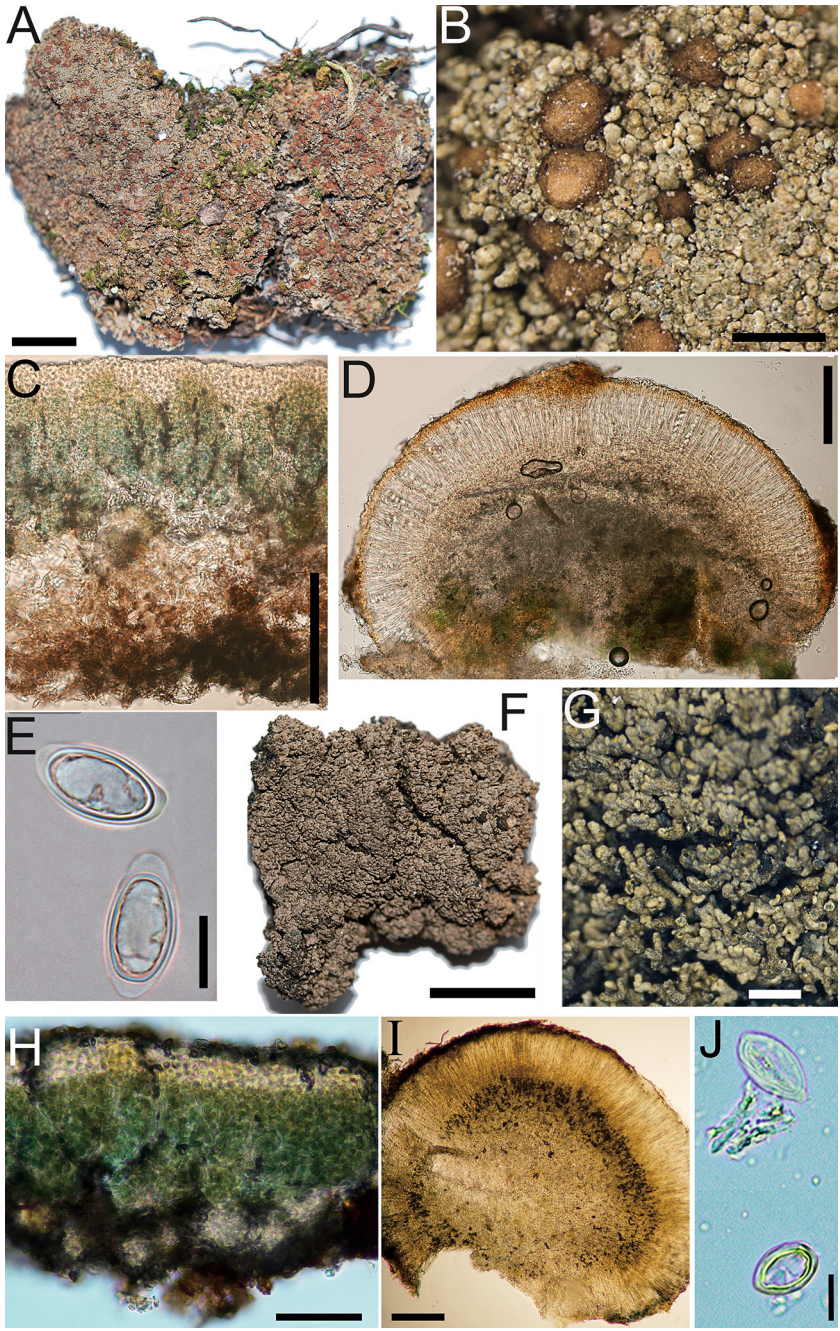
APOTHECIA lecideine, ≤300 μm thick; THALLINE EXCIPLE not seen; PROPER EXCIPLE distinct basally but without regular cellular structure, laterally lacking when mature; EPIHYMENIUM reddish-brown, 10–15 μm thick; HYMENIUM 80–150 μm thick, hemiamyloid; SUBHYMENIUM 150–160 μm; ASCI with apical amyloid ring-structure, 8-spored; ASCOSPORES colourless, simple, ellipsoid or ovoid, 15–20 × 8–10 μm with epispore; EPISPORE smooth, thickened and round at both ends.

Terricolous, saxicolous, corticolous or on mosses.

CHEMISTRY: All reactions negative (color test); no lichen substances detected by TLC.

SPECIMENS EXAMINED: **CHINA**. **QINGHAI PROVINCE**, Qilian County, Mt. Niuxin, 38°10′N 100°14′E, alt. 2950 m, on moss, 11/VIII/2007, Z.S. Sun 20071442 (SDNU). **SHAANXI PROVINCE**, Mei County, Mt. Taibai, 34°07′N 107°54′E, alt. 2930 m, on soil, 22/VII/1963, Q.M. Ma & Y.C. Zong DI-128 (HMSA-L 073233); alt. 2750 m, on soil, 4/VIII/2005, J.Z. Zhao 813 (HMSA-L 073225); alt. 3180–3500 m, 4–5/VIII/2005, on bark, M.R. Huang 2612 (HMSA-L 075386), on moss, M.R. Huang 3042 (HMSA-L 075411), 3041 (HMSA-L 075412), 3043 (HMSA-L 075413), 2474 (HMSA-L 075414), 2482 (HMSA-L 075415), on soil, 2505 (HMSA-L 075419); alt. 2350 m, on soil, 16/VI/2011, H.Y. Wang 20114996a (SDNU). **SICHUAN PROVINCE**, Xiaojin County, Changpinggou, 31°11′N 102°51′E, alt. 3300 m, on stump, 22/VIII/1996, L.S. Wang 96-17750 (KUN); Kangding County, Liuba Town, 29°28′N 101°32′E, alt. 3100 m, on shrub, 9/IX/1996, L.S. Wang 96-16449 (KUN); Daocheng County, Mt. Haizishan, 29°10′N 100°24′E, alt. 4390 m, on rock, 19/IX/2002, L.S. Wang 02-22259 (KUN); Maerkang County, Dazang Road, 31°54′N 102°12′E, alt. 3200 m, on rock, 7/IX/2007, L.S. Wang 07-29429 (KUN). **XIZANG PROVINCE**, Changdu County, Mt. Machala, 31°12′N 96°36′E, alt. 4650 m, on rock, 20/VIII/2004, L.S. Wang, 04-25557 (KUN).

REMARKS: *Fuscopannaria cheiroloba* is characterized by the granule-like central squamules giving a crustose appearance, the broader and fan-shaped marginal squamules without white-felted margins, a rather thick algal layer (120–130 μm) and the absence of lichen substances. It grows on various substrates in montane forests in China.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Fuscopannaria cheiroloba, which morphologically resembles *F. praetermissa* (Nyl.) P.M. Jørg., differs by the presence of fan-shaped marginal squamules and the absence of terpenoids and fatty acids. *Fuscopannaria saltuensis* P.M. Jørg. is also similar to *F. cheiroloba* but has smaller, thinner marginal squamules and smaller ascospores (12–14 × 8–9 µm; Jørgensen 2000a).

Fuscopannaria cheiroloba has been recorded from the USA and Canada (Jørgensen 2000b, Jørgensen et al. 2010). Jørgensen et al. (2010) suggested that "it is endemic to the Pacific Northwest of North America where it apparently is a high elevation species". Our materials, similar to those in USA and Canada in morphology and chemistry (Jørgensen 2000b, Jørgensen et al. 2010), were also collected at high elevations (2350–4650 m). This is the first report from Asia, and its occurrence in China seems to reflect a disjunct distribution between the western North America and China.

Fuscopannaria coralloidea P.M. Jørg., Bryologist 103: 681 (2000). Pl. 2 F–J

Thallus squamulose, forming a rosette of 5–6 cm diam.; squamules numerous, crowded, commonly suberect, deeply and repeatedly branched, with coralloid outgrowths and giving a cushion-like appearance, <0.5 mm wide, plane to slightly convex, somewhat swollen at apex, with entire, glabrous and not white-felted margin; upper surface uniformly brown, smooth, glabrous, without isidia, soredia, lobules and pruina, dull to slightly shiny; lower surface whitish to buff; hypothallus indistinct, blackish to black. Apothecia scarce, scattered, visible on the upper surface, often partly covered by but not hidden in squamules; thalline margin not seen; disc brown to dark brown, 1–1.5 mm diam., strongly convex.

Thallus heteromerous, ≤180 µm thick; upper cortex distinct, pale brown to brown, 25–30 µm thick, cells thick-walled; algal layer 80–110 µm thick, *Nostoc* in chains, embedded in a gelatinous layer; medulla 30–40 µm thick; lower cortex and rhizines absent.

Apothecia lecideine, ≤700 µm thick; thalline exciple not seen; epihymenium dark-brown, 10–15 µm thick; hymenium 130–170 µm thick; asci with apical amyloid ring-structure, 8-spored; ascospores colourless, simple, ellipsoid or ovoid, obtuse at both ends, 15–20 × 8–10 µm with smooth epispore.

On soil-covered rocks.

Plate 2. ***Fuscopannaria cheiroloba*** (HMAS-L 075411). A. Thallus; B. Central squamules and apothecia; C. Cross-section of thallus; D. Cross-section of apothecium; E. ascospores. ***Fuscopannaria coralloidea*** (KUN Wang 09-30569). F. Thallus; G. Coralloid cushion-like squamules; H. Cross-section of thallus; I. Cross-section of apothecium; J. Ellipsoid or ovoid ascospores. Scale bars: A, F = 1 cm; B, G = 1 mm; C, D, I = 150 µm; E, J = 10 µm; H = 50 µm.

Chemistry: All reactions negative (color test); no lichen substances detected by TLC.

Specimens examined: **CHINA**. **Yunnan Province**, Dongchuan County, Luoxue Town, 26°09′N 102°55′E, on soil-covered rock, alt. 4020 m, 18/VII/2009, L.S. Wang 09-30569 (KUN).

Remarks: *Fuscopannaria coralloidea* is a species of the *F. praetermissa* complex, characterized by a coralloid and cushion-like appearance due to the suberect and branched squamules with abundant outgrowths. *Fuscopannaria abscondita* P.M. Jørg. has a similar coralloid appearance, but is distinguished by having apothecia hidden in squamules rather than visible from above, a higher and more convex cushion-forming thallus (≤1 cm high), and spores with oil droplets (Jørgensen 2000b, Jørgensen & Zhurbenko 2002, Nash et al. 2002).

Fuscopannaria coralloidea is new to Asia and shows a disjunct distribution between western North America and China. It was previously known from the U.S.A. Pacific coast, where it has a lowland distribution and favors moist habitats, especially on mossy soil near rivers or lakes (Jørgensen 2000b, Nash et al. 2002). The Chinese material is similar to that from the US in morphology and ecology (also collected from a moist habitat near Jinsha River), but is found at higher altitudes (alt. 4000 m).

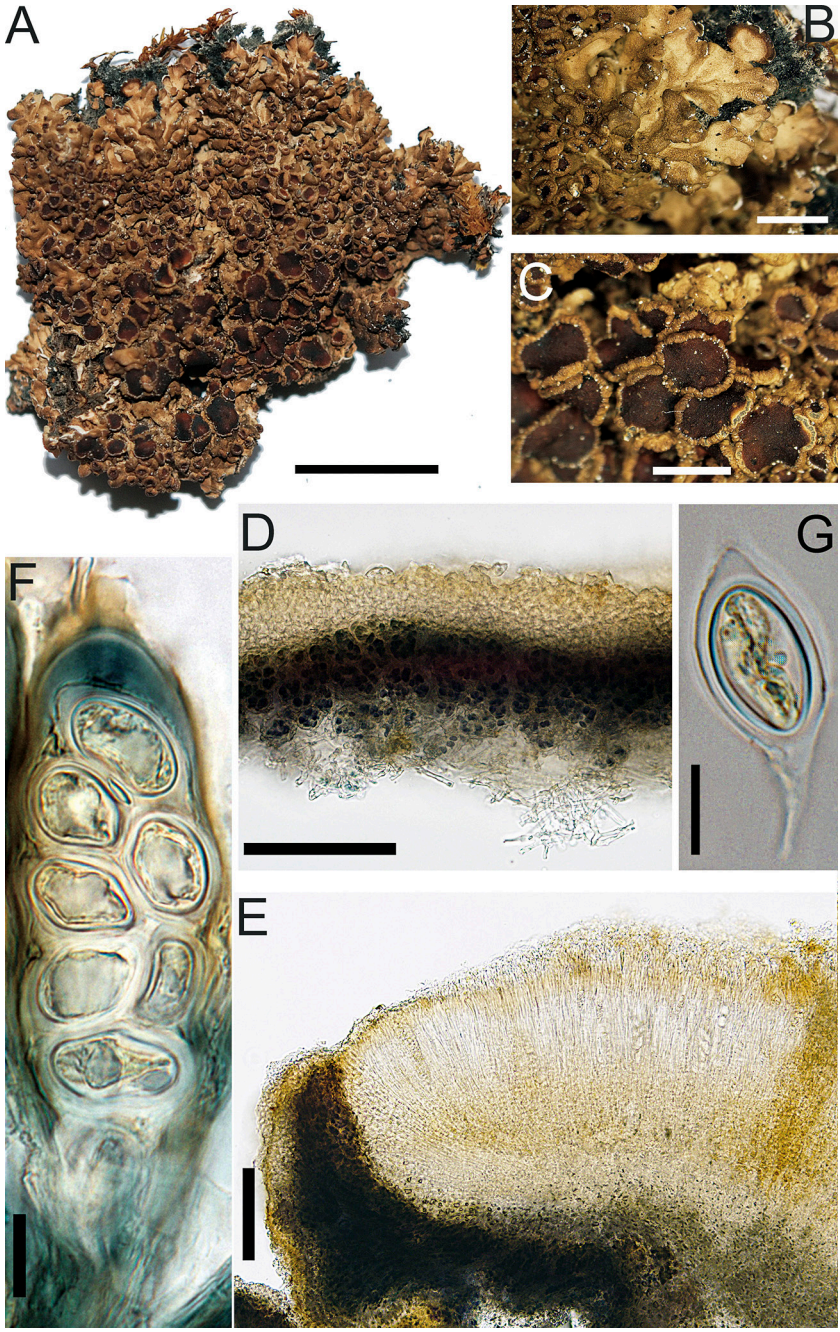
Fuscopannaria protensa (Hue) P.M. Jørg., J. Hattori Bot. Lab. 76: 205 (1994). Pl. 3

Thallus foliose, orbicular, spreading, ≤4 cm in diam.; lobes radiating, about 5 mm wide, slightly branched, entire; upper surface brown-ochre, becoming darker at apex, glabrous, scabrid, without isidia, soredia and lobules, plane, often concave at margin; lower surface with black-blue rhizines at the margin; hypothallus not seen. Apothecia abundant, laminal to submarginal, often crowded at the center of the thallus, ≤4 mm in diam.; disc brown, flat; thalline exciple distinct, concolorous with the thallus, glabrous, smooth, crenulate, with white maculae.

Thallus heteromerous, 120–130 μm thick; upper cortex pale brown, pseudoparenchymatous, 20–40 μm thick; algal layer 20–40 μm thick, *Nostoc* cells in dense clusters with little jelly; medulla 20–30 μm thick; lower cortex absent.

Apothecia lecanorine, ≤400 μm thick; thalline exciple 75–90 μm thick laterally, with cortex and algal layer similar to thallus; proper exciple

Plate 3. ***Fuscopannaria protensa*** (KUN Wang 04-23238). A. Thallus; B. Lobes, showing the scabrous upper surface, concave margin and darker apex; C. Apothecia with crenulate and maculate margin; D. Cross-section of thallus; E. Cross-section of apothecium; F. Ascus and ascospores; G. Ascospores, showing distinct, smooth epispore with one end acuminate. Scale bars: A = 1 cm; B, C = 2 mm; D, E = 100 μm; F, G = 10 μm.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indistinct; EPIHYMENIUM pale brown, 10–20 μm high; HYMENIUM 130–150 μm thick, hemiamyloid; SUBHYMENIUM 70–150 μm thick; ASCI clavate, with apical amyloid ring-structure, 8-spored; ASCOSPORES simple, ellipsoid, hyaline, 20–30 × 10–12 μm with episporе; EPISPORE acuminate at least at one end, smooth, colourless.

Corticolous.

CHEMISTRY: All reactions negative (color test); terpenoids and fatty acids present (TLC).

SPECIMENS EXAMINED: **CHINA**. **YUNNAN PROVINCE**, Shangri-La County, Gezan Town, Mt. Daxueshan, 28°34′N 99°50′E, on *Rhododendron*, alt. 4060 m, 15/VI/2004, L.S. Wang 04-23238 (KUN); Lijiang County, Mt. Yulongxueshan, Ganheba, 27°05′N 100°16′E, on spruce, alt. 3000 m, 16/V/2005, L.S. Wang 05-24437 (KUN).

REMARKS: *Fuscopannaria protensa* is characterized by the brown-ochre, foliose thallus with radiating lobes and spores with an episporе that is acuminate at least at one end. *Fuscopannaria leucosticta* also has a maculate thalline exciple and acuminate episporе but differs by the brown, squamulose thallus with smooth upper surface and white-felted lobe margins. *Fuscopannaria poeltii* (P.M. Jørg.) P.M. Jørg. differs in its white-felted lobe margins and spores with rounded episporе.

Fuscopannaria protensa was previously known from Korea and Japan (Jørgensen 2000a). It is rare in China and only two collections were found from Yunnan. Our materials closely resemble those from outside China, except for slightly longer spores (18–25 × 10–12 μm including episporе in Korean and Japanese materials; Jørgensen 2000a).

Acknowledgements

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